

MEMORANDUM

To: Barry Fountos
From: Karoline Gourley
re: Palomares Records
date: September 29, 1997

In my continuing search for records pertaining to the Palomares accident, I wanted to let you know what I have found and where additional information is located pertaining to Palomares.

Dosimetry measurements taken at the time of the accident were done for 1,586 people, primarily of Air Force, Army or Navy personnel. Of these 1,586 it is possible that 38 were from residents. The U.S. Air Force Radiological Health Laboratory should have these dosimetry records.

The Coordination and Information Center in Las Vegas, NV has 214 documents pertaining to Palomares. Martha DeMarre is sending me a 36 page printout providing details of these documents to permit us to make an informed research request. The CIC does not have any dosimetry records pertaining to the incident.

It is apparent also that there is a fair amount of published literature pertaining to Palomares. I have tracked a number of references to technical articles, many of which have been published in Health Physics and other scientific journals. If tracking down these published documents is a goal, one would most likely need to obtain as many as possible from the DOE library and beyond that go to OSTI. If you would like me to compile a list of published literature I could probably compile that before my October travel starts again.

J. Newell Stannard, the author of Radioactivity and Health: A History, also wrote about the Palomares incident. I have attached copies of the pages of his book which pertain to Palomares, including some of his footnotes. Some of his footnotes involve personal notes and conversations which Stannard makes available to researchers. Therefore I have attached Stannard's address and phone number, should someone want to contact him. He retired many, many years ago, but I think these numbers are pretty current.

In addition, my research indicates that there should be further original source documentation pertaining to Palomares in the following locations:

- ☐ DOE history division archives The files in the history division are likely to contain policy-making decision type documents. They may provide leads as to which AEC laboratories were performing what type of work on this incident. Pertinent collections include:
 - Files of the Atomic Energy Commission Secretariat
(both in the 1958-1966 and 1966-1972 collections)
 - McCraw Files
 - General Managers Reading Files
 - Files of the AEC Division of Military Application

- ☐ National Archives at College Park. The history division has recently transferred some pertinent material to the National Archives. The most pertinent collection there is:
 - AEC Division of Biology & Medicine
- ☐ Los Alamos. One of the leading scientists involved in the evaluation of the contamination at Palomares was Wright Langham. Wright Langham was a Los Alamos scientist who was most likely called upon for Palomares because of his expertise with plutonium and its deposition in humans, expertise he gained through the now well-publicized plutonium injections. Langham has written numerous articles on the subject and based on reading Stannard's chapters, it appears that Los Alamos still has many papers belonging to Langham. My research indicates that Los Alamos also has some additional classified technical reports.
- ☐ Lawrence Livermore. Livermore developed an instrument to measure plutonium contamination in the field. The instrument, specifically developed for Palomares, is a Field Instrument for Detection of Low Energy Radiation (FIDLER). It would be logical for Livermore to know where the readings taken by FIDLER are kept.
- ☐ Oak Ridge National Laboratory. I found a number of leads that suggest ORNL has had some involvement with Palomares, but so far nothing very specific has been suggested.
- ☐ Spain. According to Stannard's book, Dr. Eduardo Ramos of the Junta de Energia Nuclear Division de Medicina y Proteccion, with money from the AEC, conducted periodic surveys of the contaminated regions and occasionally of the inhabitants. A paper presented to the International Radiation Protection Association by Dr. Emelio Iranzo and Salvador in 1970 documented this.

Radioactivity and Health A History

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after the shot to check on retention factors. Over two thousand plutonium analyses were generated by this segment of the operation alone. The results, naturally, did not appear overnight.

3. The Results

Despite every attempt at its avoidance, random variability was as inherent in this experiment as the earlier ones. However, the sheer mass of data made the discernment of trends less irksome.

The results that came largely from the reports of Wilson and Terry (1965a,b) are summarized below:

- a. The aerosols were well characterized thanks especially to the expert contributions of the U.K. participants. Fairly large particles frequently contributed sizeable fractions of the total activity. Nevertheless, the early analyses of lung burdens showed close relationships to the information from the air samplers. "An animal is a competent sampler" (Wilson and Terry 1965a, p. 281).
 - b. Initial deposition was about 23% of the respirable aerosol in dogs, about 11% in sheep, and about 18% in burros.
 - c. Short-term clearance half-times were about four days for dogs, five days for sheep, and about ten days for burros.
 - d. The sheep cleared much more plutonium by fast component kinetics. Thus, the amount of plutonium left for long-term clearance differed considerably among the species: 67% of the initial burden in dogs, 51% in sheep, and 22% in burros.
 - e. The clearance kinetics for the Clean Slate II shot, which had much more inert dust, were different. Much more was cleared by dogs and sheep in the first seven days (Wilson and Terry 1965a, p. 285). As a result, the remaining lung burdens at seven days were only 5.5% of the respirable aerosol for Clean Slate II versus 15.9% for Double Tracks in the dogs and 0.4 versus 2.1 in the sheep. The organizers of the project had occasion to wish that they had been able to devote as much attention to these differences and aerosol-animal interactions as they did to Double Tracks, since they could influence hazard evaluations. (2)
 - f. The findings indicated that neither animals alone nor samplers alone would have sufficed to describe the respiratory hazard. Yet, the relatively good agreement between the two contrasts with the earlier tests and with much industrial hygiene experience.
 - g. Mean radiation doses to infinite time for the three species studied ranged, for the aerosol of Double Tracks, from 0.96 rem in the dog to 0.08 rem in the sheep. The extrapolation to humans was 0.3 rem.
 - h. There was little evidence of build-up of plutonium in tissues other than lung, and possibly respiratory lymph nodes. Thus, for this exposure, the lung appears to be the critical organ.
- In the final evaluation (Stewart and Wilson 1968), the same basic points were confirmed, but there was much more: (1) on the kinetics of lung clearance, including the fact that a power function fits the data; (2) on the reliability of the characterizations; (3) on the point that the patterns of PuO_2 behavior in the
- (a) This may be a non sequitur since the tendency is always to choose the most conservative case, and that would be the cleaner aerosol for Double Tracks, which was studied most extensively.

dog seen in this field experiment are very similar to those found in laboratory experiments; and (4) showing that the results from each animal species form a consistent set, i.e., the differences are not random. There was a tendency to view the burro as the best model for humans.

The difference between Double Tracks and Clean Slate II aerosols led to calculation of a factor of about three difference in the ten-year dose to lungs, with the Double-Tracks-type aerosol the higher.

In all the reams of data and discussion, it is hard to find a simple succinct statement from the investigators that Operation Roller Coaster did or did not confirm the importance of the cloud passage uptake and doses versus those from inhalation of resuspended material as drawn from the work of Test Group 57. However, since the cloud passage data are used for the calculation of dose, the discussion of hazard, and development of criteria, we must assume that the answer to this question was affirmative, although the planning was such that little else could be expected.

4. Comment

Plutonium radiochemistry is a slow process. It appears that one reason there seems to have been no grand finale in the reporting and analysis of either Test Group 57 or, especially, Operation Roller Coaster, is that there are still data requiring analysis. A letter from R. G. Thomas to R. H. Wilson (Thomas 1981) raises the question of what may or may not be waiting and also refers to the many soil samples taken by the University of California, Los Angeles (UCLA) team (especially Kermit Larson) in Area 13 that remain unanalyzed. We will see in a later section that conscious attempts have been made to go back over these contaminated areas (see the section on the NAEG). Yet, there seems to be some possible unfinished business from these two major operations.

E. Palomares and Thule

The Palomares and Thule incidents were accidents, not planned projects, and thus were not "Safety Tests." Yet, they need to be mentioned in this review. The one at Palomares, Spain, occurred on January 17, 1966. As a result of a refueling accident (collision) involving a B-52 bomber and a KC-135 tanker over the Mediterranean Ocean, four nuclear weapons were released from the bomber. Two were recovered intact, one from the Mediterranean about five miles offshore and one from a dry riverbed east of the Spanish village of Palomares (population about 1,000), on the coast. The other two underwent high explosive detonation, one at the east edge of the village, the other about one mile to the west. With a thirty-knot wind blowing out of the west, the dust containing ^{239}Pu , ^{240}Pu , and ^{241}Pu travelled across irrigated fields at the edge of the village in the one case and over truck garden areas just outside of town in the other. There was no nuclear yield in either.

The Thule incident occurred on the ice near Thule, Greenland, when an onboard fire forced ditching of a B-52 aircraft on January 21, 1968. Again there were detonations of the high explosive charges and contamination of the environment with plutonium, but no nuclear yield.

As mentioned earlier, these internationally important events were described briefly in an open literature publication by Stannard (1973). Much more detail is hidden away in the general discussions of plutonium contamination of the environment by Langham (1968, 1969, and 1971), in a trip report concerning his

return visit to Palomares and the collaborative efforts with the Danish at Thule (Langham 1972), and, for Thule, a special edition of the *Journal USAF Nuclear Safety* entitled, "Project Crested Ice" (USAF 1970). (a) The primary actions were to remove as much of the plutonium as possible from the surface and ship it back to the United States. Residual contamination at Thule was minimal since the plutonium that was not removed was gradually diluted into the sea. However, there were full-fledged examinations of biota and an extensive ecological program managed primarily by the Danes (Aarkrog 1971a,b; 1977), and by W. C. Hanson of the Hanford Labs (1971, 1972, 1975).

Langham (1972) describes the continuing work at Palomares carried out largely by a joint effort of the Junta de Energia Nuclear Division de Medicina y Proteccion headed by Dr. Eduardo Ramos, with equipment and operational support from the AEC. After the clean-up of the most contaminated area, (b) the project settled down to periodic surveys of the environment and occasionally of the inhabitants. Long-term contamination levels of humans or environment have not been sufficient to cause real concern. The levels of airborne plutonium and uranium within the village were consistently below the maximum permissible concentration (MPC) (Iranzo and Salvador 1970). Samples nearer the sites of impact recorded maximum values of gross alpha activities above the MPC on fourteen occasions in the second half of 1966 and in 1967. The MPC was exceeded by a factor of ten on three days. These were during periods of high winds and much resuspension of the deposited radionuclides. Interestingly, the incidence of measurable uranium in the air exceeded that of plutonium; 30% of the samples showed no trace of plutonium, while only 3% showed no trace of uranium.

This work is continuing, albeit at a relatively low level. (c) Fortunately, both of these incidents occurred in areas of low habitation density. Unfortunately, for the measurements, the area around Palomares happens to have one of the highest alpha-particle backgrounds in Spain, and the low-level measurements easily got lost in it.

Finding more detailed technical evaluations and their contributions to international emitter research and hazardous analysis is not easy. The joint Spanish-U.S. reports and Spanish in-house reports would be useful, but are not readily available. The most convenient summary for the technical reader of the work done at Palomares over the first several months is a paper by Odland et al. (1968) (d) given at the seventh Hanford biology symposium (see chapter 8 for these symposia) and the International Radiation Protection Association (IRPA) report by Iranzo and Salvador (1970), which concerns longer periods. The results reported

(a) The author has copies of these documents that he would be glad to make available to interested readers. They are unclassified. There are also book-length descriptions of the events themselves and much in news magazines of the day (see Odland et al. 1968).

(b) The ugly scar left on the fragile semiarid landscape, from the clean-up operation, impressed Langham as the most significant long-term result of the incident.

(c) It was the author's privilege to meet Dr. Emelio Iranzo, Dr. Ramos's colleague in the Spanish operations, at the 1964 meeting of the Health Physics Society and to be informed that the work is still under way.

(d) This paper gives rather complete references to descriptions in the popular press (*Business Week*, *Commonwealth*, *Life*, *Newsweek*, *Saturday Evening Post*, *Saturday Review*, and *U.S. News and World Report*) and reports from the PHS. A book-length description by Lewis (1967) is also cited.

by Odland include analysis of urine samples, nose swipes, water from various sources, such as the Mediterranean Sea and shower effluents, and radioactivity in soil and on vegetation samples. The urine samples came primarily from Air Force, Army, or Navy personnel involved in the clean-up operations. Only 38 out of 1,586 were other, and it is not clear whether or not these were residents. (Probably the prime source of data for the residents is in the Spanish literature, and this contained mostly long-term concentrations in air.) The plutonium analyses were done, for both initial and resamples taken several months later, by the U.S. Air Force Radiological Health Laboratory. Systemic body burdens of plutonium were calculated by the Langham equation for a single acute exposure (Langham 1956; for further discussion see chapters 7 and 16).

Of the 1,586 urine samples analyzed for the acute phase operations, 20 showed calculated body burdens greater than the maximum permissible, 422 showed plutonium concentrations between 0.09 and 0.09 of this value, 537 showed values between 0.09 and 0.009 of the above, and 607 showed calculated body burdens less than 0.009 of the maximum permissible. When we consider that these came from a hastily gathered group of personnel brought in for the acute phase of the operation, such a distribution of body burdens may be considered as satisfactorily low. However, these individuals wore protective clothing and took precautions that an uninitiated, untrained resident might not.

The nose swipes in the Odland work were negative, and the amounts in vegetation (e.g., tomatoes) were lower than reported in some of the magazine versions. However, the crops were condemned anyway.

The Air Force operated a resampling program for urinary plutonium content involving 422 personnel, all but 7 of them military. There were 6 cases with greater than 10% of the allowable systemic body burden, 213 were between 1% and 10%, 39 less than 1%, and 164 below the limits of detection.

One individual died during the study, of causes unrelated to plutonium exposure. The plutonium content of lung was about 500 pCi, calculated for the whole lung, while the last urine sample showed no detectable activity. This suggests the possibility of insoluble deposits of plutonium in lung and the virtues of resurveying the group with whole-body counters.

In view of the probable lack of protective actions taken by the Spanish residents and the airborne concentrations of alpha activity reported (e.g., by Iranzo and Salvador), it is surprising that there have not been reports of significant body burdens in any of these individuals. It can only be speculated whether this means that the levels were consistently low, the necessary measurements difficult, or not done, or the reports not generally disseminated. It is also surprising that measurements appear not to have been made in the indigenous animals and that animals were not brought in as stand-ins for humans (Wilson 1984).

The plutonium at Palomares does not seem to have descended very far into the soil; perhaps to be expected in a semiarid climate. Population and commercial pressures are prompting the inhabitants to expand gardening activities ever closer to the contaminated area (W. J. Bair, personal communication, October 1985). This makes it essential that the monitoring and survey activities be continued. It even augers for possible pressure for more removal of surface and near-surface soil for disposal.

Further follow-up of Palomares is reputed to be under way by personnel from several American laboratories under the Department of Energy (DOE): Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), Oak Ridge National Laboratory (ORNL), as well as DOE Headquarters

and by the Spanish authorities (e.g., Iranzo). No information has appeared that would change the conclusions drawn above.

Similar summaries of personnel monitoring for the Thule event, from both Danish and U.S. sources, are contained in *USAF Nuclear Safety* cited above. However, few quantitative data are given there. The emphasis is more on the environment. This is as it should be by the circumstances of the event, and much important information is contained in this review. A succinct summary and analysis of the work of Project 56, Test Group 57, and Operation Roller Coaster and how this work made it easier to react effectively to the accidents at Palomares and Thule were written by Harry Jordan at Los Alamos. His summary refers to some of the classified reports from the Nevada operations and gives also details on the contents of the Air Force document, "Project Crested Ice," cited above (Jordan 1971).

A resurvey of eight locations near Thule was carried out in 1974 (Hanson 1980) as part of a general review of the concentrations and inventories of ^{137}Cs , ^{239}Pu , and ^{240}Pu in soils, lichens, and animals from northern Alaska and Greenland. Average inventories of ^{239}Pu of Thule lichen communities, not directly contaminated by accident debris, were not significantly different from those in Alaska lichen carpets in 1968 and 1974, respectively. Thus, the Thule area was no higher six years after the incident than other Arctic areas possessing the unique lichen step in the food chain. Soil samples contained about $10\text{--}15\text{ Ci of }^{239}\text{Pu/g}$. More details of the Thule ecological work can be found in publications by Aarkrog (1971a,b, 1977) and by Hanson (1971, 1972, 1975). These papers concern primarily the transport of plutonium in the subject ecosystems and are more appropriately considered as part of chapter 15. Much hinges on the $^{239}\text{Pu}/^{137}\text{Cs}$ ratios.

III. Long-Term Follow-Up— The Nevada Applied Ecology Group

A. Genesis

In 1970, the AEC established an organization known as the Nevada Applied Ecology Group (NAEG) whose purpose included the following objectives:

1. Determine how and to what extent radioecological processes had redistributed plutonium and determine its uptake and food-web pathways in the biota of the NTS.
2. Guide and coordinate ecological, radiation monitoring and other environmental programs necessary to support continued nuclear testing activities.
3. Provide the mechanism to effectively comply with the requirements of the National Environmental Policy Act (NEPA) of 1969.

The program was planned and administered by a small scientific staff based at Nevada Operations Office (NVO). Principals in developing and administering NAEG were Jared Davis and Ernest Campbell, with the enthusiastic support of the NVO General Manager, R. E. Miller. Later the program was administered by Paul Dunaway and M. G. White, under the NVO General Manager, General M. E. Gates. Funds for the program were distributed to many laboratories through the NAEG operations. Prime among these were: the AEC family, the Pacific Northwest Laboratory (PNL), Battelle Columbus Laboratory, LANL, LLL, UCLA, ORNL, the AEC's Health and Safety Laboratory (HASL), New York, and

National Reactor Testing Station, now the Idaho National Engineering Laboratory (INEL); and outside of AEC, the Environmental Protection Agency (EPA) and Air Resources Laboratory, National Oceanic and Atmospheric Administration (NOAA), Las Vegas and NTS, Nevada; the University of Nevada at Las Vegas and service contractors such as REECO and Rockwell, Hanford. Many others joined for specific tasks.

B. The Problems and Mode of Operation

The scientific problems attacked were varied. High priority was given to soil analyses. There was much interest in what had happened to the plutonium in the years since the shots and whether or not the solubilization processes demonstrated in earlier laboratory and field research lived up to expectations in a larger-scale, larger-area study. There was also interest in the nature of the soil-plutonium binding processes, both physical and chemical, the increasing role of americium, the processes of resuspension by wind (which we will discuss in chapter 15), and how all of these could be brought to bear on hazard analysis. An enormous effort was put into statistical analyses to guide the soil sampling procedures for example and for interpretation of the data.^(a)

There was also much work with grazing animals and native animals, including uptake and transfer from vegetation, the construction of models for the possible intakes by and doses to humans developed from the accumulated data, and some very cogent laboratory investigations of specific points raised by the findings in the field. Finally, as momentum accumulated for the development of a full-scale information repository at Las Vegas, the NAEG entered into the work of the Information Center (see chapter 12). One of the earlier steps was a selected annotated bibliography on the environmental aspects of plutonium prepared by the Division of Technical Information, USAEC and spearheaded by Helen Pfuderer with guidance from M. G. White and others (e.g., ORNL 1972 with many updates, and 1978).

The various individuals and laboratories engaged in work for the NAEG program labored at their home institutions. Communications were handled by periodic NVO reports and an annual symposium, usually held in Las Vegas, that brought the principal investigators together for in-depth progress reports and discussion of plans. There was also an advisory committee for the general operation and several advisory committees for specific areas of research. We will discuss a few areas of special pertinence to this chapter presently. A selected list of reports is given as note 2 at the end of this chapter.

Before proceeding, however, we should remark that one of the prime early objectives of the NAEG, not spelled out in the official *raison d'être*, was to establish an inventory of the transuranics present at NTS and adjacent sites. Was there a sufficient amount of plutonium and the transplutoniums to warrant clean-up measures? While Areas 11, 13, GMX, Tonopah Test Range^(b) are now among the more unlikely places for human habitation, it was argued that some day cheap irrigation water (desalinated sea water?) and the pressures of world population might change all that. People might live and grow crops in the midst of these long-lived radioactive materials! Thus, the inventory in the soil, its

(a) Until one reads these extensive compendia, it might have been thought that digging a suitable soil sample would be a simplistic if back-breaking process. Not so! It is a highly technical affair.

(b) Tonopah itself has a population of a few thousand and is growing.

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electrometer mounted atop the large volume chamber, which, because of its size and appearance was nicknamed the "milk can" by the calibration technicians and radiation monitors who used them in the field. The tube-type electrometers initially used were temperamental and not very rugged, and the units were upgraded with solid-state electrometers when these became available in the late 1950s.

More germane to internal emitter problems is the Pluto, a portable monitor for plutonium or other alpha-emitting surface contamination developed during the MED days. The instrument was named after Mickey Mouse's dog, Pluto, a very popular cartoon figure during World War II. The name, however, upset General Groves on security grounds because of its similarity to the then-secret element plutonium. He thus decreed that the name should not be used, and for a time the instrument was renamed "Sandy" after Little Orphan Annie's dog in another popular cartoon strip of the time. Officially, the instrument was designated "Snoops," but, General Groves notwithstanding, the name Pluto stuck, and, along with the Sniffy, an appropriately named air sampling device, the Pluto was one of two health instruments named in the Smyth Report published immediately after the atomic bombings of Japan (Smyth 1945).

An interesting and highly effective device for monitoring plutonium contamination in the field under adverse environmental conditions was developed as a result of a military aircraft crash in 1964 near Palomares, Spain, involving nuclear weapons. Known by its acronym FIDLER (Field Instrument for Detection of Low Energy Radiation), this device used a thin scintillation detector and a two-channel pulse height analyzer set for 17 keV and 60 keV (the plutonium and ^{241}Am photons); it is capable of detecting plutonium contamination levels of a few hundred nanocuries per cubic meter over rugged uneven terrain (Tinney, Koch, and Schmidt 1969).

Portable battery-powered spectrometers for field application made their appearance about 1960, largely made possible by the advent of the transistor. One of the earliest commercial units was a single channel analyzer made in the configuration and size of a handheld survey meter by the Eberline Instrument Company. A later version of this unit featured two channels, and subsequent models made by Eberline and other manufacturers had special features such as hard-wired detection capability of the 364-keV photon associated with ^{137}I and scanning capability.

Although some water monitoring was done in the MED, the method used was simply immersion of detectors of various types into the liquid, useful only for fairly high concentrations of beta-photon emitters. Somewhat more sophisticated monitors were developed shortly after the war, using several thin side wall G-M counters to enhance sensitivity (Hursh, Zizzo, and Dahl 1951). Isotopic measurements of specific radionuclides in water were made in the field by ordinary gamma spectroscopy techniques. A combined alpha and beta-photon water monitor was made commercially as early as 1952, having both G-M and ZnS(Tl) detectors (AEC 1952). Systems have also been made for continuous measurement of tritium in water using a flow diversion-mixing technique and liquid scintillation counting.

VIII. In-Vivo Counting

In its simplest form, in-vivo counting could be accomplished by using a G-M survey meter to detect iodine in the thyroid if the activity levels were sufficiently

high (figure 18.15). Direct field measurement of internal emitters in vivo was accomplished by use of whole-body counters, which were made relatively lightweight and transportable and, hence, suitable for field use. Early whole-body counters were simply large shielded rooms; one such unit, developed at Brookhaven National Laboratory, weighed twenty-one tons and was transported by ship for use in fallout studies of the Marshall Islands (Cohn et al. 1963). Shadow-shield whole-body counters were pioneered at the Hanford Laboratories (Palmer and Roesch 1965) and made into portable truck-mounted units (Svanberg 1963; Brady and Svanberg 1965). A similar mobile whole-body counter was also developed in Sweden (Van Döbeln 1965). Although the sensitivity of these devices was initially not nearly as good as could be achieved in the laboratory using large shielded rooms with graded shields, for many applications, particularly for detection of fission products, these devices are more than adequate. In a typical unit, subjects would lie on their back on a cot or bed which was moved underneath a large NaI(Tl) crystal shielded overhead and on the sides by lead. Thus, a traverse of the body was obtained. The shadow-shield detector had a background as low as the large iron room systems, and weighed only five tons (Palmer and Roesch 1965). Thus, it could be loaded into a truck or even onto aircraft to make in-vivo field measurements and was used in studies of fallout in school children in the Hanford area and in Eskimos and Laplanders in the Arctic; and in the Marshall Islands (see chapter 12, which includes a photograph of one such unit). The modern successor to the original Hanford design is now commonly used at nuclear power plants to routinely monitor workers for internal exposure to fission products. The much more ponderous and sensitive non-portable (laboratory) versions of in-vivo counters are described in chapter 17.

The transportable units described here are simply modifications of the larger laboratory versions.



FIGURE 18.15. Field measurement of radioiodine contamination in the thyroid during the 1940s. (Photo courtesy of Pacific Northwest Laboratory.)

Portable survey instruments were also used to detect possible internal contamination from radionuclides, particularly the radioiodines, which are relatively rapidly taken up and localized in the thyroid (figure 18.15). Routine contamination surveys at the time of the accident

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